

## The Two Stages of Photosynthesis

Photosynthesis is a complex process. During photosynthesis, plants and some other organisms use energy from the sun to convert carbon dioxide and water into oxygen and sugars. The process of photosynthesis is shown in Figure 3. You can think of photosynthesis as taking place in two stages: capturing the sun's energy and producing sugars. You're probably familiar with many two-stage processes. To make a cake, for example, the first stage is to combine the ingredients to make the batter. The second stage is to bake the batter. To get the desired result—the cake—both stages must occur in the correct order.

**Stage 1: Capturing the Sun's Energy** The first stage of photosynthesis involves capturing the energy in sunlight. In plants, this energy-capturing process occurs mostly in the leaves. Recall that chloroplasts are green organelles inside plant cells. The green color comes from **pigments**, colored chemical compounds that absorb light. The main photosynthetic pigment in chloroplasts is **chlorophyll**.

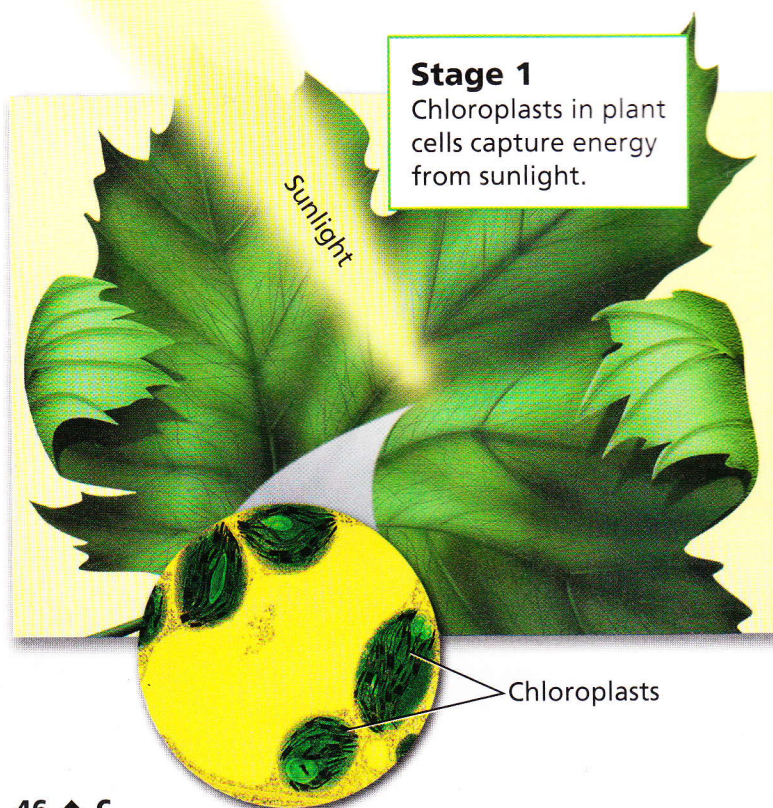
Chlorophyll functions in a manner similar to that of the solar "cells" in a solar-powered calculator. Solar cells capture the energy in light and use it to power the calculator. Similarly, chlorophyll captures light energy and uses it to power the second stage of photosynthesis.

FIGURE 3

### Two Stages of Photosynthesis

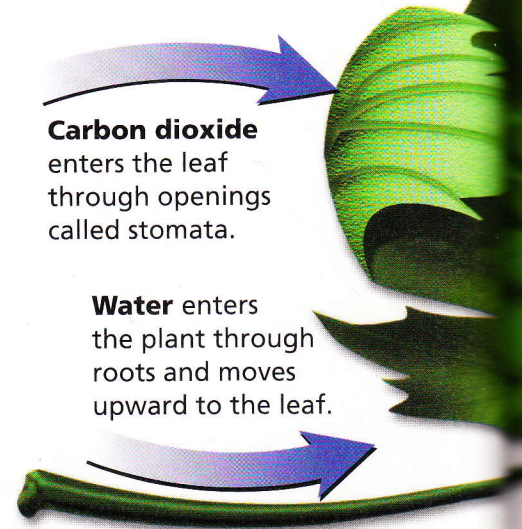
Photosynthesis has two stages, as shown in the diagram.

**Interpreting Diagrams** Which stage requires light?



### Stage 2

The captured light energy is used to produce sugars and oxygen from water and carbon dioxide.



Carbon dioxide enters the leaf through openings called stomata.

Water enters the plant through roots and moves upward to the leaf.



**Stage 2: Using Energy to Make Food** In the next stage of photosynthesis, the cell uses the captured energy to produce sugars. The cell needs two raw materials for this stage: water ( $\text{H}_2\text{O}$ ) and carbon dioxide ( $\text{CO}_2$ ). In plants, the roots absorb water from the soil. The water then moves up through the plant's stem to the leaves. Carbon dioxide is one of the gases in the air. Carbon dioxide enters the plant through small openings on the undersides of the leaves called **stomata** (STOH muh tuh) (singular *stoma*). Once in the leaves, the water and carbon dioxide move into the chloroplasts.

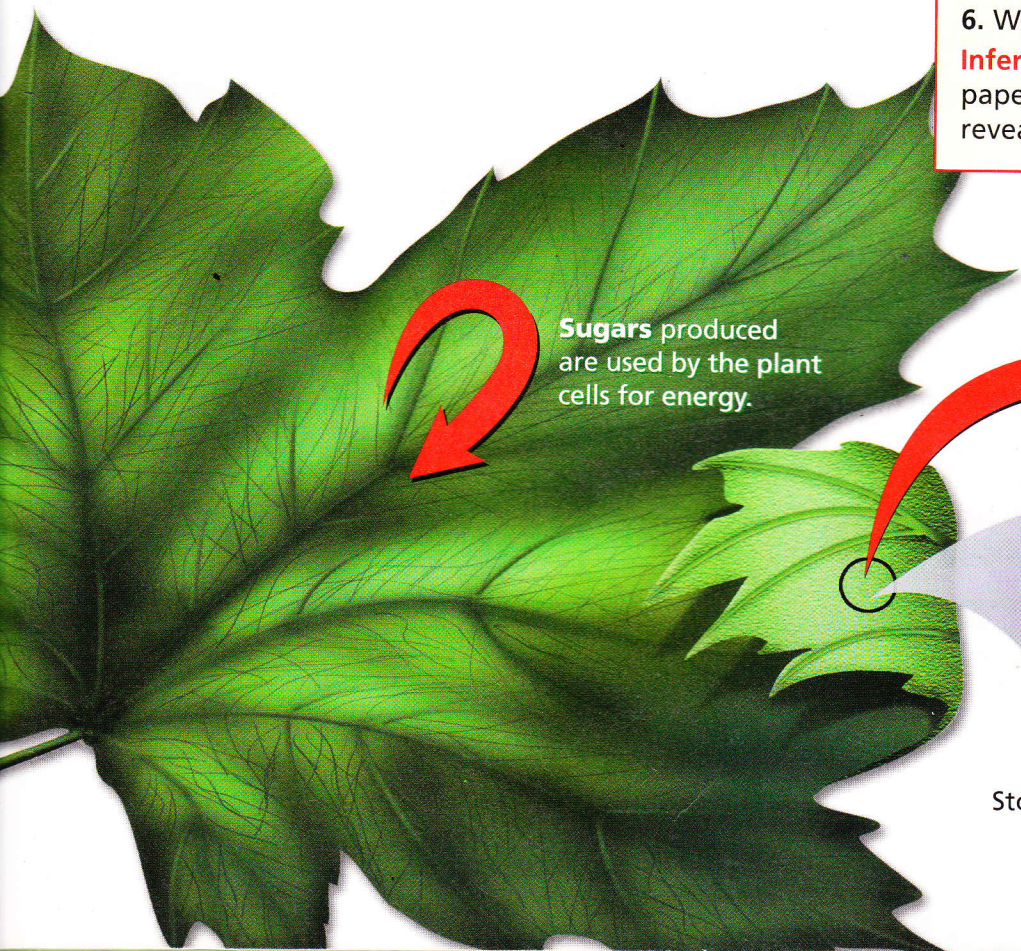
Inside the chloroplasts, the water and carbon dioxide undergo a complex series of chemical reactions. The reactions are powered by the energy captured in the first stage. These reactions produce chemicals as products. One product is a sugar that has six carbon atoms. Six-carbon sugars have the chemical formula  $\text{C}_6\text{H}_{12}\text{O}_6$ . Recall that sugars are a type of carbohydrate. Cells can use the energy in the sugar to carry out important cell functions.

The other product of photosynthesis is oxygen ( $\text{O}_2$ ), which exits the leaf through the stomata. In fact, almost all the oxygen in Earth's atmosphere was produced by living things through the process of photosynthesis.

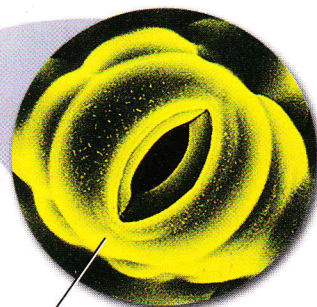


**Reading  
Checkpoint**

What makes plants green?



**Sugars** produced are used by the plant cells for energy.



Stoma




**Oxygen** exits through stomata on the underside of the leaf.

**Lab  
zone**

## Try This Activity

### Looking at Pigments

You can observe the pigments in a leaf.

1. Cut a strip 5 cm by 20 cm out of a paper coffee filter.
2.  Place a leaf on top of the paper strip, about 2 cm from the bottom.
3. Roll the edge of a dime over a section of the leaf, leaving a narrow band of color on the paper strip.
4.   Pour rubbing alcohol into a plastic cup to a depth of 1 cm. Stand the paper strip in the cup so the color band is about 1 cm above the alcohol. Hook the other end of the strip over the top of the cup.
5. After 10 minutes, remove the paper strip and let it dry. Observe the strip.
6. Wash your hands.

**Inferring** What does the paper strip's appearance reveal about leaf pigments?

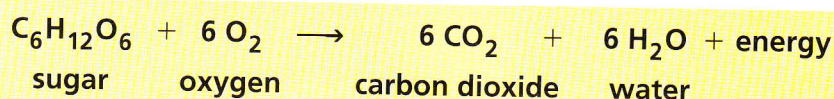


**The Two Stages of Respiration** Like photosynthesis, respiration is a two-stage process. The first stage takes place in the cytoplasm of the organism's cells. There, molecules of glucose are broken down into smaller molecules. Oxygen is not involved, and only a small amount of energy is released.

The second stage of respiration takes place in the mitochondria. There, the small molecules are broken down into even smaller molecules. These chemical reactions require oxygen, and they release a great deal of energy. This is why the mitochondria are sometimes called the "powerhouses" of the cell.

Trace the steps in the breakdown of glucose in Figure 7. Note that energy is released in both stages. Two other products of respiration are carbon dioxide and water. These products diffuse out of the cell. In most animals, the carbon dioxide and some water leave the body during exhalation, or breathing out. Thus, when you breathe in, you take in oxygen—a raw material for respiration. When you breathe out, you release carbon dioxide and water—products of respiration.

**The Respiration Equation** Although respiration occurs in a series of complex steps, the overall process can be summarized in the following equation:



Notice that the raw materials for respiration are sugar and oxygen. Plants and other organisms that undergo photosynthesis make their own sugar. The glucose in the cells of animals and other organisms comes from the food they consume. The oxygen used in respiration comes from the air or water surrounding the organism.

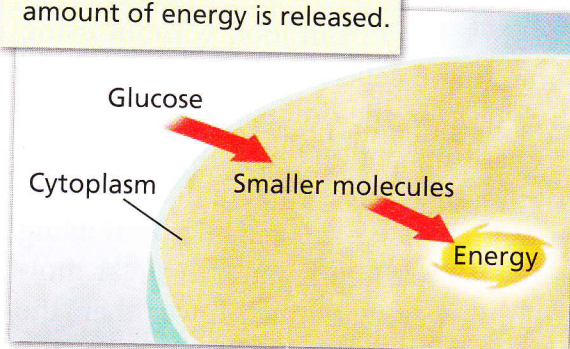
**FIGURE 7**

**Two Stages of Respiration**

Respiration, like photosynthesis, takes place in two stages.

**Interpreting Diagrams** In which stage of respiration is oxygen used?

**Stage 1** In the cytoplasm, glucose is broken down into smaller molecules. A small amount of energy is released.



**Stage 2** In the mitochondria, the smaller molecules combine with oxygen to produce water and carbon dioxide. This reaction releases a large amount of energy.

